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Doppler Shift Analysis for Enhanced Satellite Communication in Low Earth Equatorial Orbits

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Abstract
Satellite communications are crucial to the global telecommunications infrastructure, with approximately 2000 satellites orbiting Earth to relay analog and digital signals. These satellites, moving at an average speed of 27,358 km/h, induce Doppler frequency shifts that can significantly impact communication reliability. This study investigates the Doppler frequency shift across various carrier frequency bands (L, S, X, Ku, and Ka) in Low Earth Equatorial Orbit (LEEO) satellites. Utilizing Matlab simulations to model orbital paths at different altitudes, this research quantifies the Doppler shifts and corresponding rates for each frequency band. Results indicate a direct correlation between higher carrier frequencies and increased Doppler shifts, underscoring the need for effective Doppler compensation techniques to enhance communication link performance. The findings provide essential data for optimizing Phase Lock Loop (PLL) designs in transceivers, which is crucial for future satellite operations in equatorial regions. © 2024 IEEE.

Author Keywords
doppler frequency shift; Doppler rate analysis; Ka-band; Ku-band; Low Earth equatorial orbit; phase lock loop optimization; satellite communication networks

Index Keywords
Communication satellites, Orbits, Radio transceivers, Satellite communication systems, Satellite links, Satellite relay systems, Satellite simulators, Tropics; Dopple rate analyze, Doppler frequency shift, Doppler rates, Equatorial orbits, Ka band, Ku band, Loop optimizations, Low earth equatorial orbit, Phase lock, Phase lock loop optimization, Rate analysis, Satellite communication networks; Phase locked loops

References

- Bousquet, M.
  Satellite Communications and Space Telecommunication Frequencies
  (2017) *Handbook of Satellite Applications, J. N. Pelton, S. Madry, and S. Camacho-Lara, Eds., Cham*, pp. 325-357.
  Springer International Publishing

- Sobolewski, J.S.
  Data transmission media
  (2003) *Encyclopedia of Physical Science and Technology (Third Edition)*, pp. 277-303.
  R. A. Meyers, Ed., New York Academic Press

- Narayanasamy, A., Ahmad, Y.A., Othman, M.
  Nanosatellites constellation as an IoT communication platform for near equatorial countries
  (2017) *IOP Conference Series: Materials Science and Engineering*,
  Institute of Physics Publishing, Nov

- Ellis, P., Van Rheeden, D., Dowla, F.
  Use of Doppler and Doppler Rate for RF Geolocation Using a Single LEO Satellite
  (2020) *IEEE Access*, 8, pp. 12907-12920.

- Sidiku, M.B., Sani, S.M., Muazu, M.B., Mohammad, A.
  (2017) *Development of A Modified Link Budget for Low Earth Orbiting (Leo)-Based Land*

Mobile Satellite Communications System,
[Online]

- Zhang, Q., Sun, H., Feng, Z., Gao, H., Li, W.
Data-Aided Doppler Frequency Shift Estimation and Compensation for UAVs
(2020) *IEEE Internet Things Journal*, 7 (1), pp. 400-415.
Jan

- Neinavaie, M., Khalife, J., Kassas, Z.M.
Acquisition, Doppler Tracking, and Positioning with Starlink LEO Satellites: First Results
IEEE Transactions on Aerospace and Electronic Systems, 58 (3), pp. 2606-2610.
Jun. 2022

- Liu, W.
Multi-scene Doppler power spectrum modeling of LEO satellite channel based on atlas fingerprint method
(2021) *IEEE Access*, 9, pp. 11811-11822.

- (2018) *Yll Doppler Compensation for LEO*,
Accessed: Jan 16 2023. [Online].Available

- Amiri, S., Mehdipour, M.
(2007) *Accurate Doppler Frequency Shift Estimation for Any Satellite Orbit*,
3rd International Conference on Recent Advance in Space Technologies 602-607, June 2007

- Jana, S., Rakshit, G., Maitra, A.
Aliasing effect due to convective rain in Doppler spectrum observed by micro rain radar at a tropical location
(2018) *Advances in Space Research*, 62 (9), pp. 2443-2453.

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